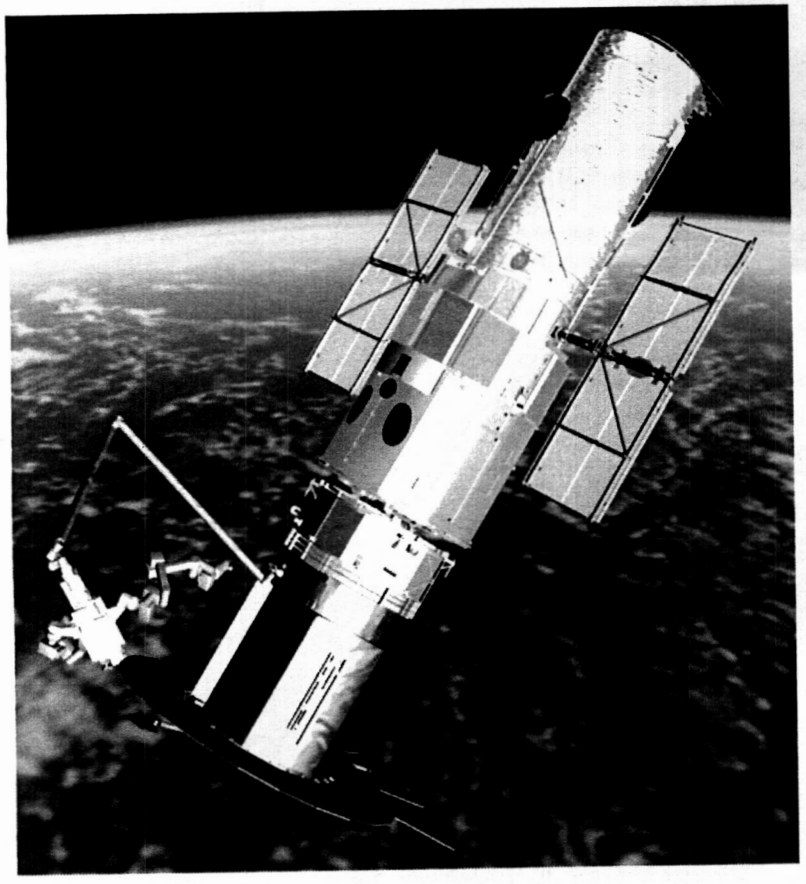
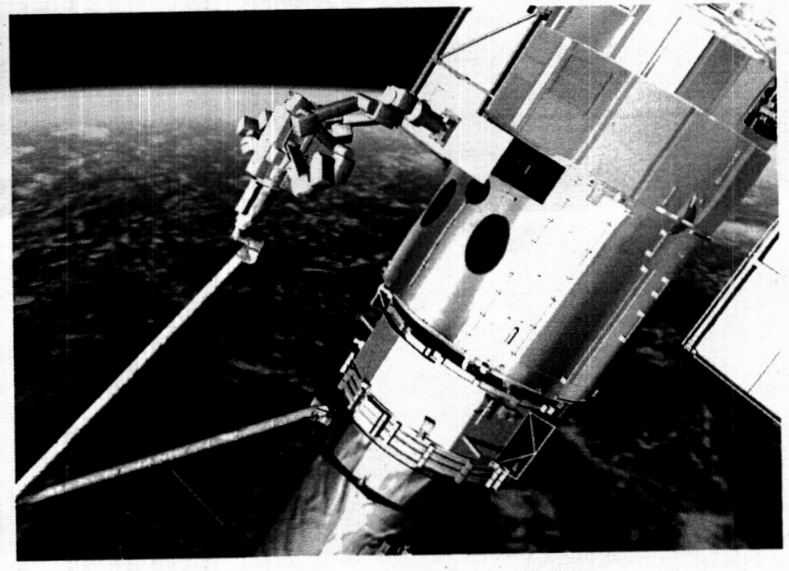
Wide Field Camera 3 Accommodations for HST Robotics Servicing Mission

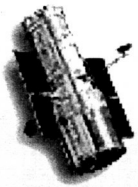




Amani Ginyard

NASA-GSFC Contamination Engineer

2005 NASA Contamination and Coatings Workshop



Acknowledgements

David Hughes

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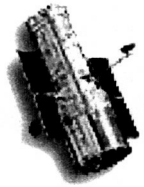
Overview

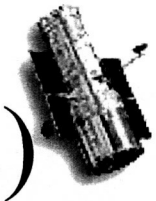
- HRSDM
  - Mission Objective
  - Hubble Robotic Vehicle
- What is Wide Field Camera 3 (WFC3)?
- Contamination Accommodations for WFC3
  - RSU analysis
  - IR Vent Tube

HST Robotics Servicing and De-orbit Mission (HRSDM) Objectives



- Provide a disposal capability at the end of HST's useful scientific life
  - The De-orbit Module (DM) will remain attached to the aft bulkhead on HST after servicing is complete
- Upgrade hardware by installing two new scientific instruments
  - Replace the Corrective Optics Space Telescope Axial Replacement (COSTAR) with the Cosmic Origins Spectrograph (COS)
  - Replace Wide Field / Planetary Camera-2 (WFPC2) with Wide Field Camera-3 (WFC3)
- Extend scientific life of HST for a minimum of 5 years after servicing

HRV Element Functionality (1 of 2)



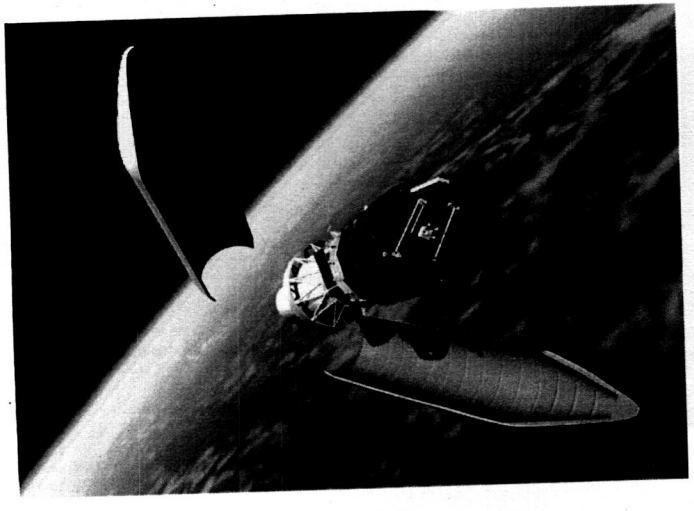
- Hubble Robotic Vehicle (HRV) is made up two spacecrafts and two robotic elements
  - The two spacecrafts are the De-orbit module (DM) and Ejection module (EM)
    - De-orbit module (DM)
      - Provide sensors and intelligence to rendezvous with HST
      - Support life extension activities
      - Provide disposal capabilities of HST at the end of its useful life
    - Ejection module (EM)
      - Houses all elements which are not required after robotic servicing
      - New science instruments are stored inside EM
      - Robotic elements are housed in or mounted on EM

HRV Element Functionality (2 of 2)

- The Robotic System is made up of two elements: Grapple Arm (GA) and Dexterous Robot (DR)
  - Grapple arm is used to capture HST
  - Dexterous robot is used to handle payload elements and perform servicing tasks

HRV Mission Overview (1 of 2)

1



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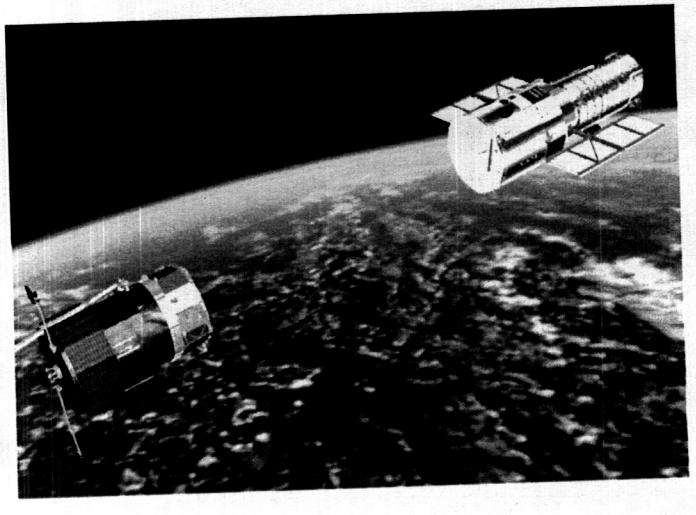

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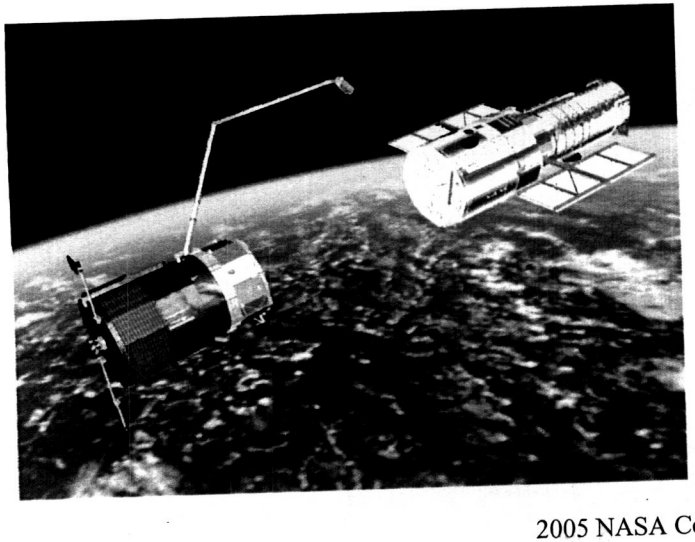

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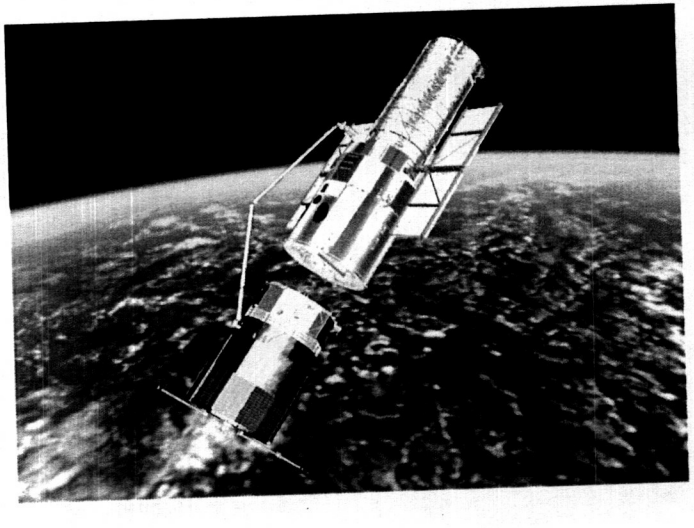

HRV Mission Overview (2 of 2)

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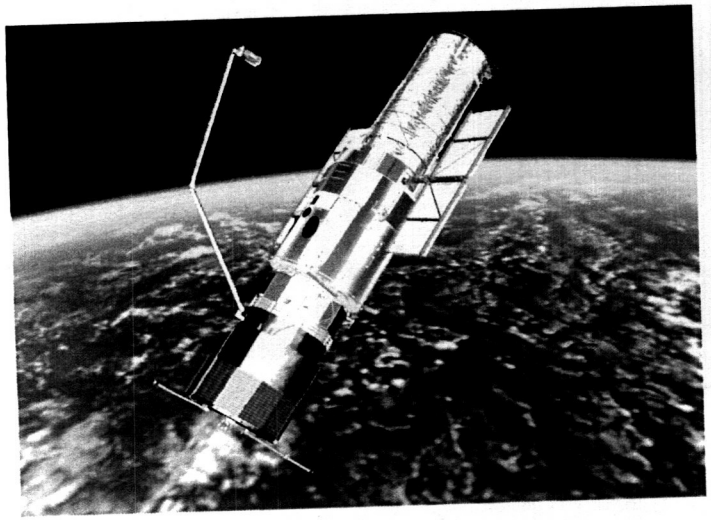

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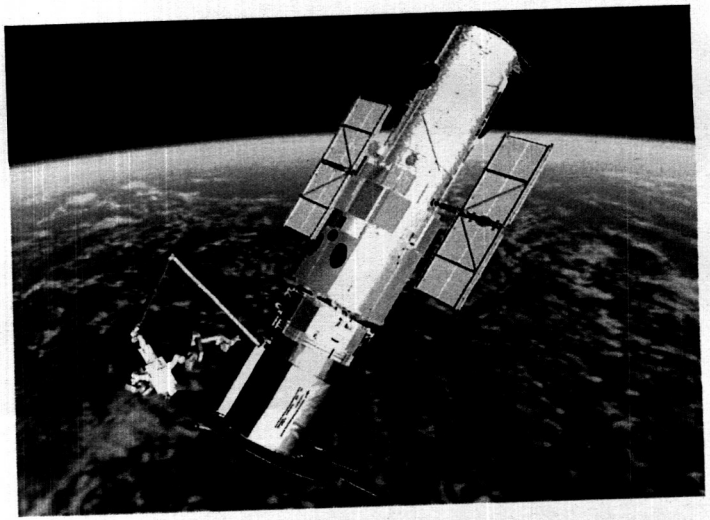

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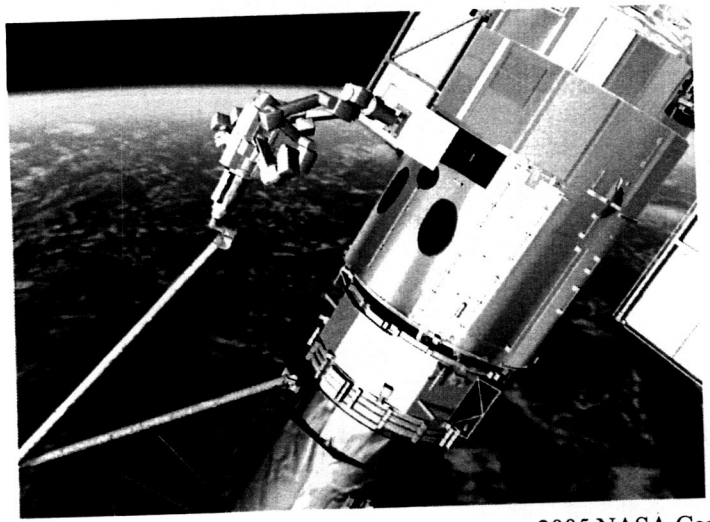

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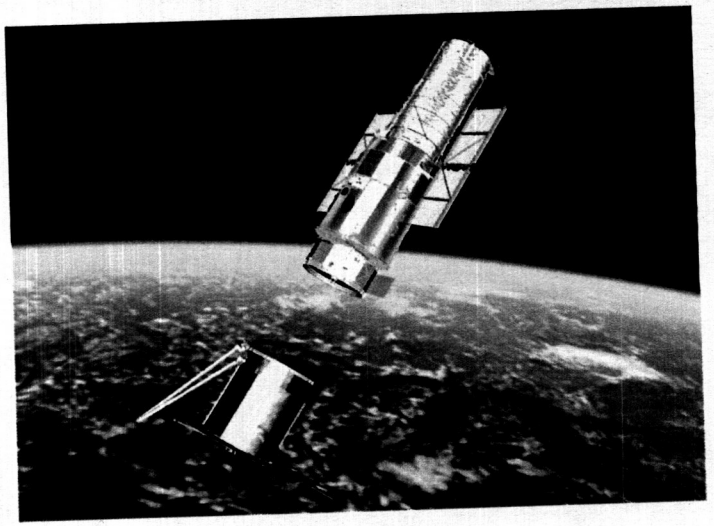
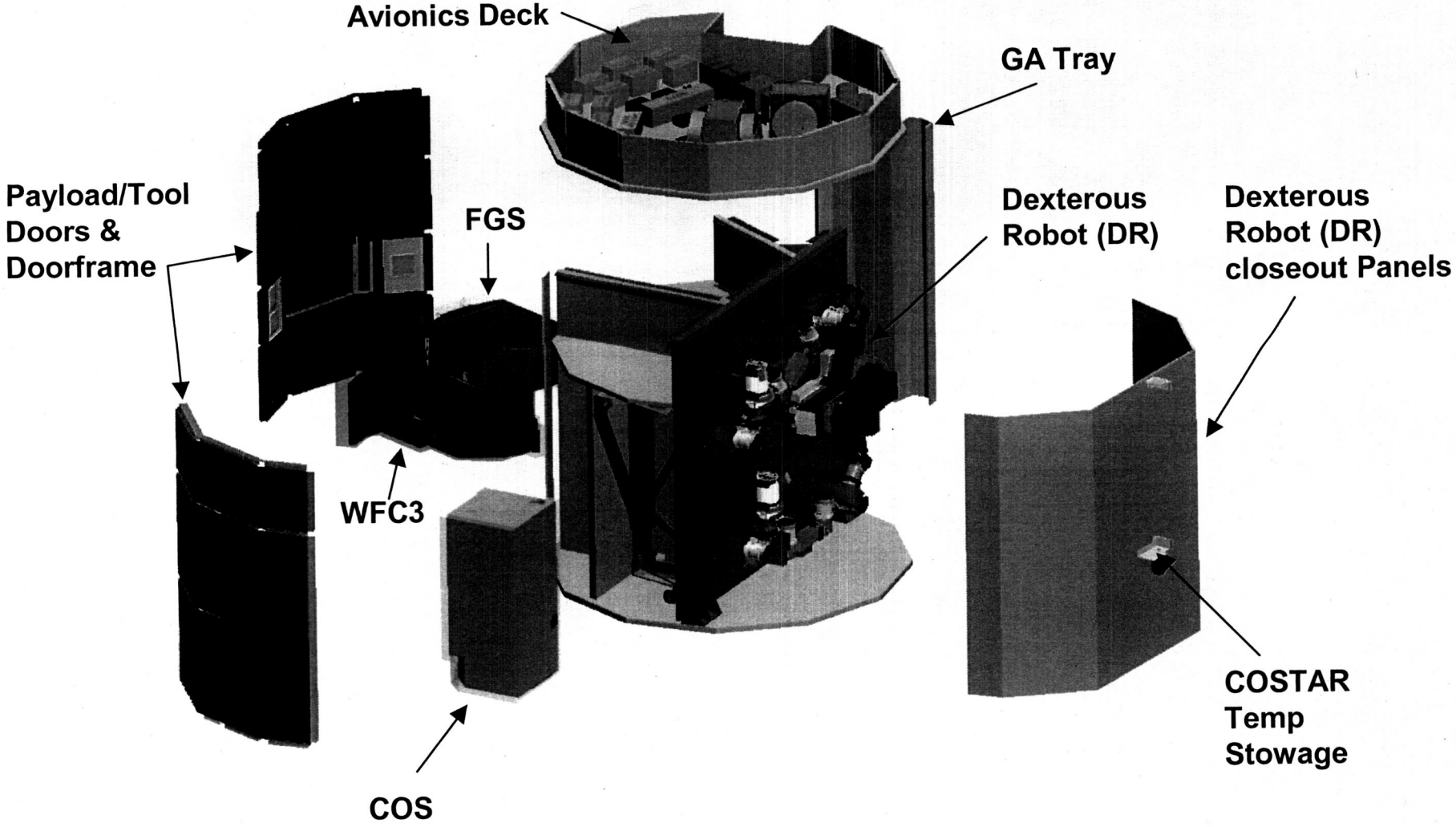


Hubble Robotic Vehicle

EM Robot and Instrument Module

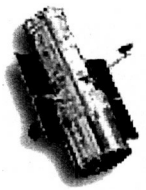


What is WFC3?

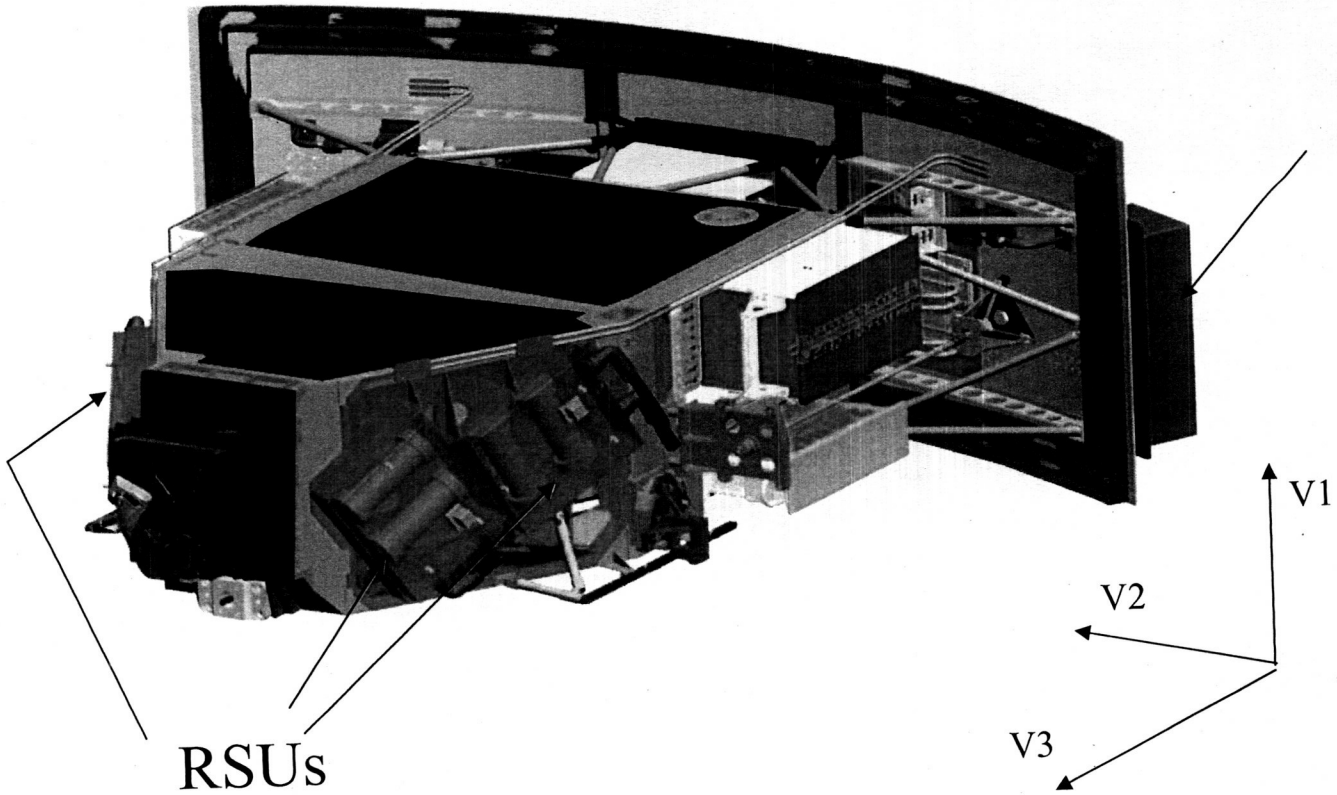
- Provide HST with high quality imaging capability until the end of the HST mission
- WFC3 will be the first "panchromatic" camera on HST
  - Two channels cover Near-UV to Near-IR (200-1700 nm) without cryogen
- Facility-class scientific instrument
  - Built for the benefit of the HST user community, with no guaranteed observing time for the developers.

Wide Field Camera 3

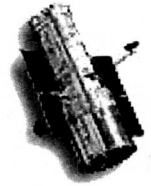
- WFC3 will provide the HST replacement gyros
  - The Rate Gyroscope Assembly (RGA) II is made up of one Electronic Control Unit (ECU) to support (3) Rate Sensor Units (RSUs)
  - Total of 6 Gyros housed in 3 RSU "boxes"
  - The (3) RSU boxes will be attached to the front diagonal panels of the WFC3 Enclosure and the ECU will be on the external Radiator
    - RSU mounting platforms will meet the Pointing Control requirements
      - 3.6 arc-sec motion
      - 2.4 arc-sec/hour rate



Wide Field Camera 3

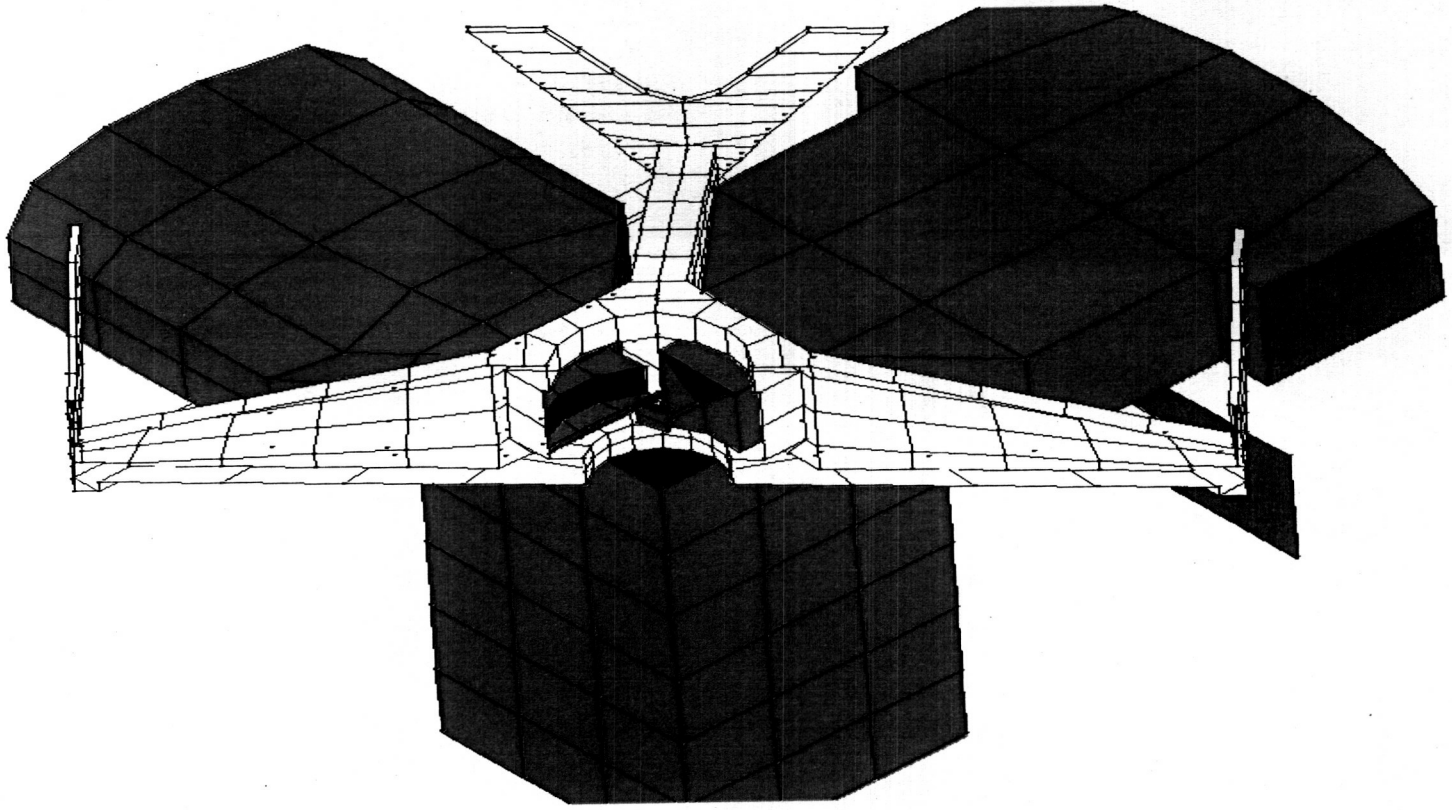


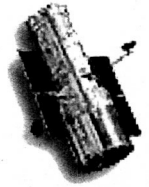
Contamination Accommodations for RSUs (1 of 4)



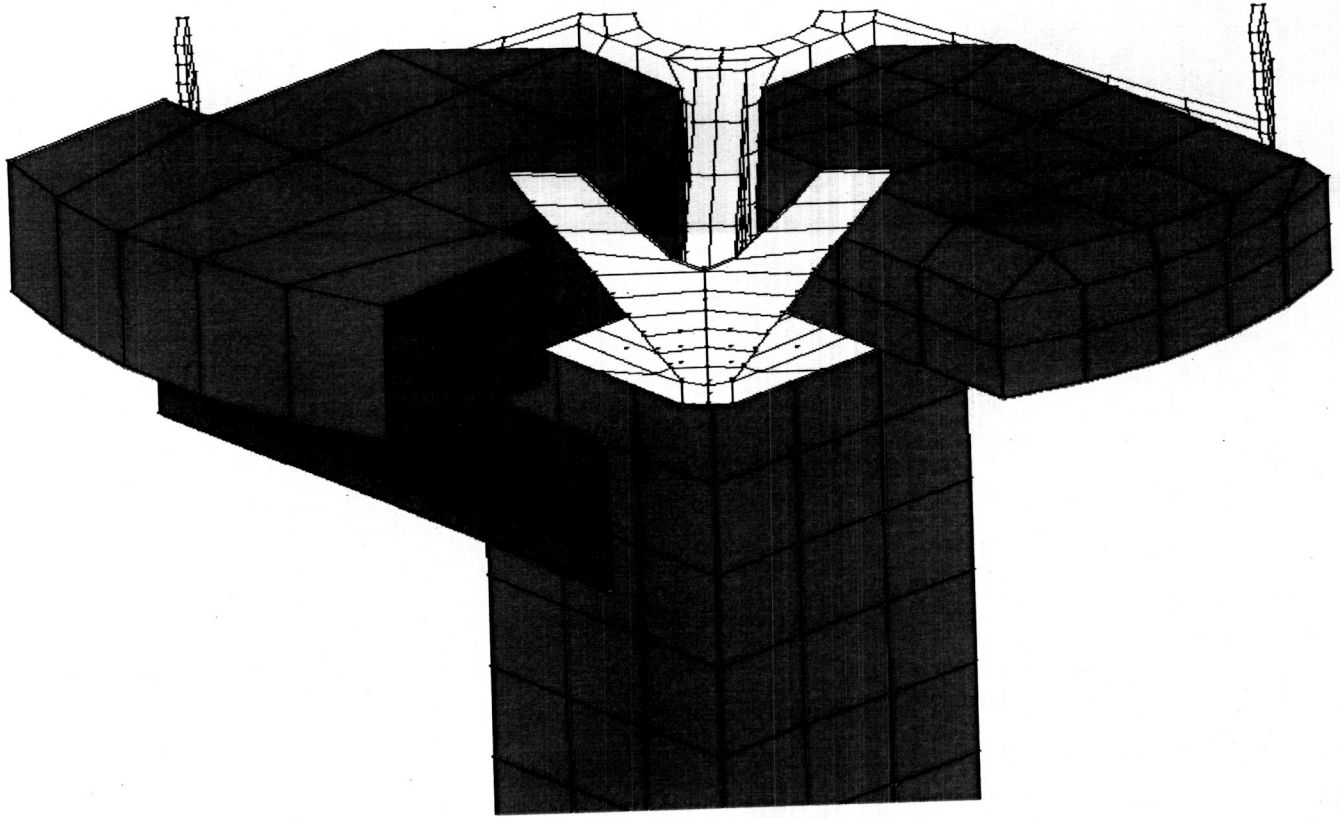
- Previous location of RSU was on the shelf below WFC3
  - Outgassing requirement of Aft Shroud: 4.33×10^{-13} g/cm^2/sec
  - Actual outgassing rate of 5.4×10^{-13} g/cm^2/sec achieved
  - Aft Shroud requirement waived by analysis
- New RSU box locations are on the sides of WFC3
  - Closer to optics
  - Analysis required to determine if actual outgassing rate is still acceptable

Contamination Accommodations for RSUs (2 of 4)





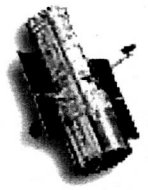
Contamination Accommodations for RSUs (3 of 4)



Contamination Accommodations for RSUs (4 of 4)

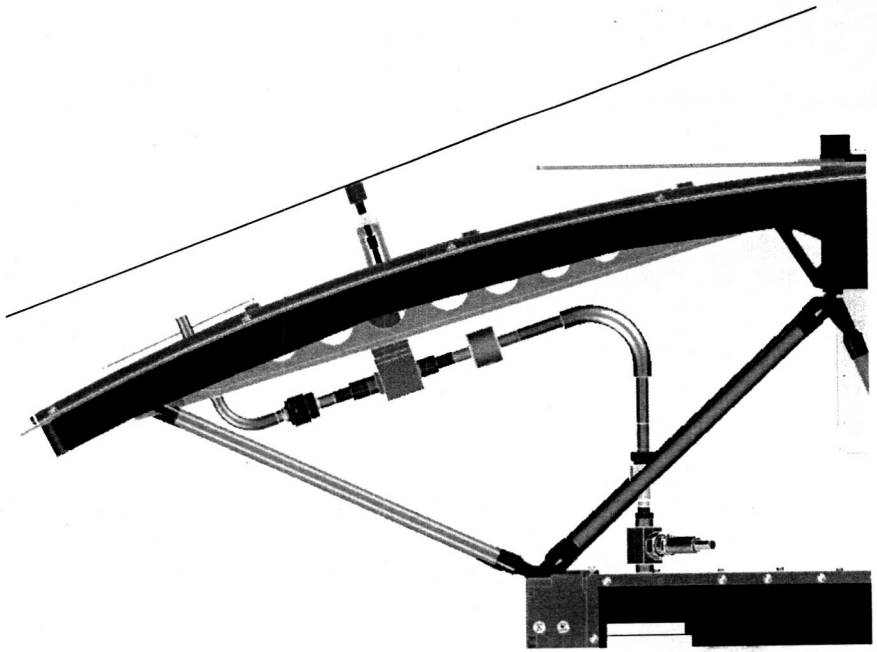
- Analysis of previous location of RSU
  - On the shelf below WFC3
  - RSU measured outgassing rate on previous missions: 5.4×10^{-13} g/cm^2/sec
  - Analysis predicted 0.01 Å accretion on WFC3 Pick-off Mirror per year
  - Results were acceptable
- Analysis of new RSU box locations
  - Attached to the front diagonal panels of the WFC3 Enclosure
  - Mr. Tony Dazzo and Mr. Dave Hughes performed analysis and modeled HST using IDEAS/TMG
  - Assume same outgassing rate achieved
  - Worst case deposition was 0.015 Å accretion
  - Results were acceptable

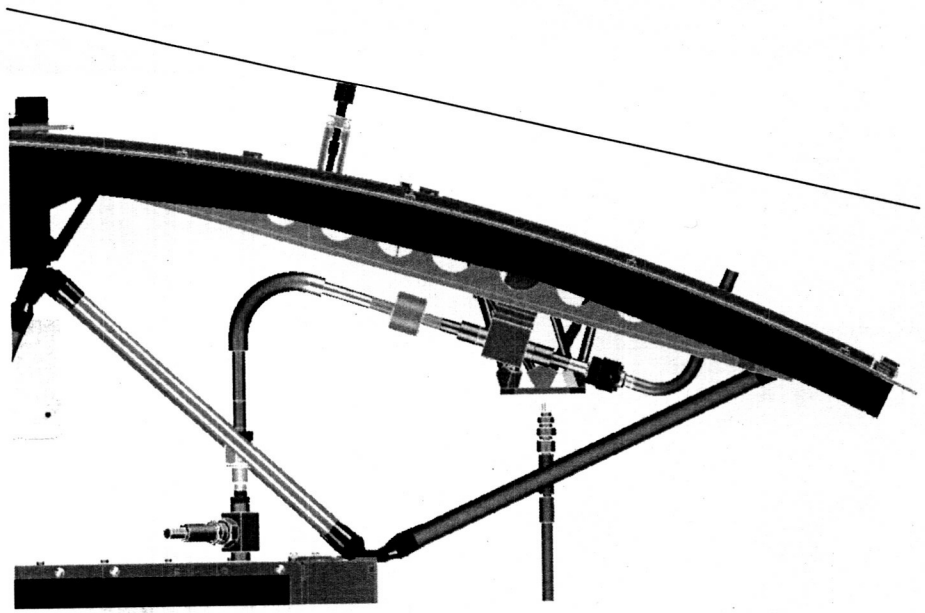
Contamination Accommodations for IR Vent Tube (1 of 2)



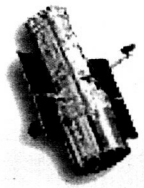
- IR Detector Vent Port Location
  - Pre-RGA II requirement: No object in line of sight of vent tube opening
  - New ECU box became the highest point on the –V2 side of radiator which is in line of sight
    - Vent tube opening in line of sight allows:
      - Exposure to contaminants and reflected outgassing to enter

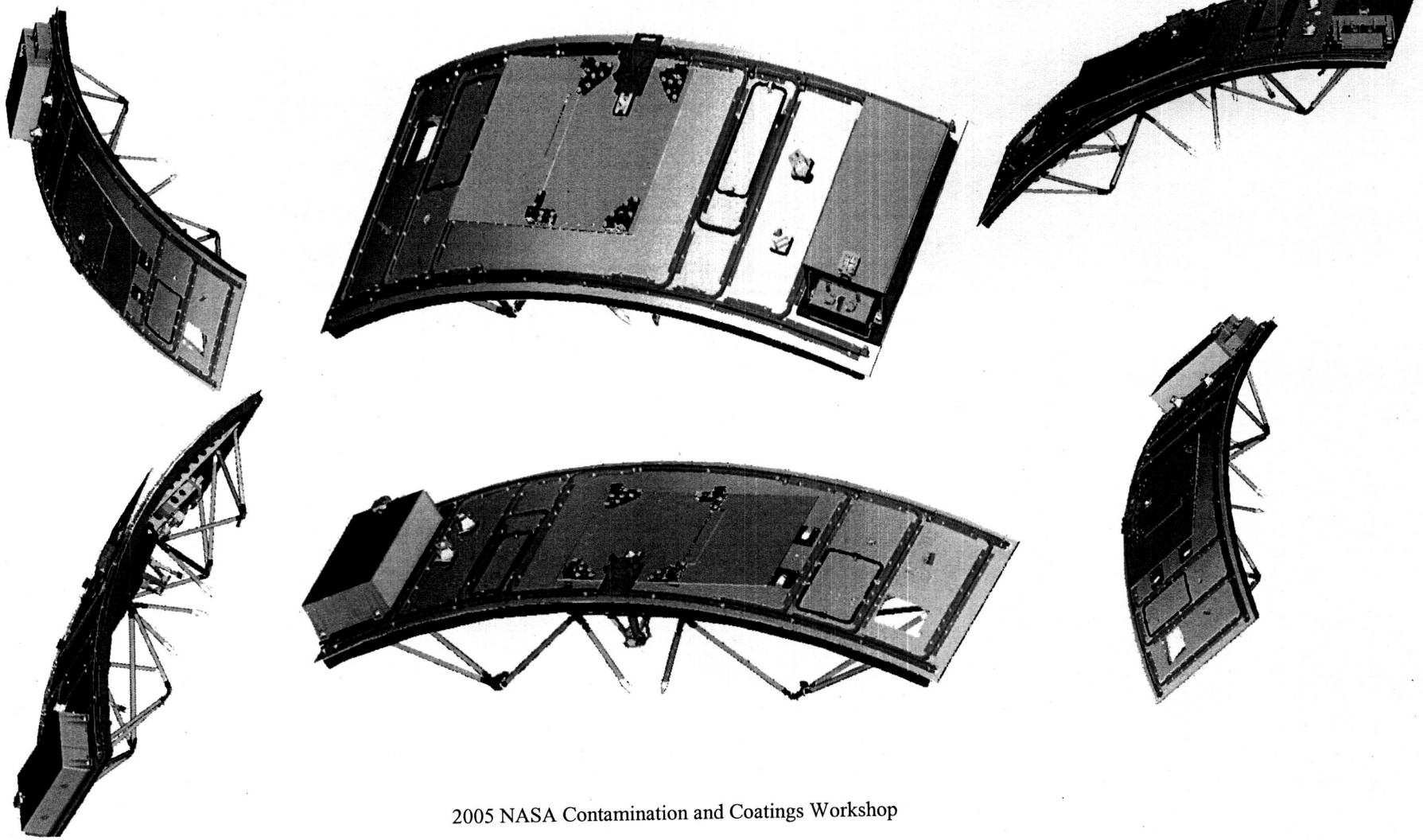
No line of sight to vent tubes

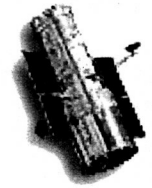




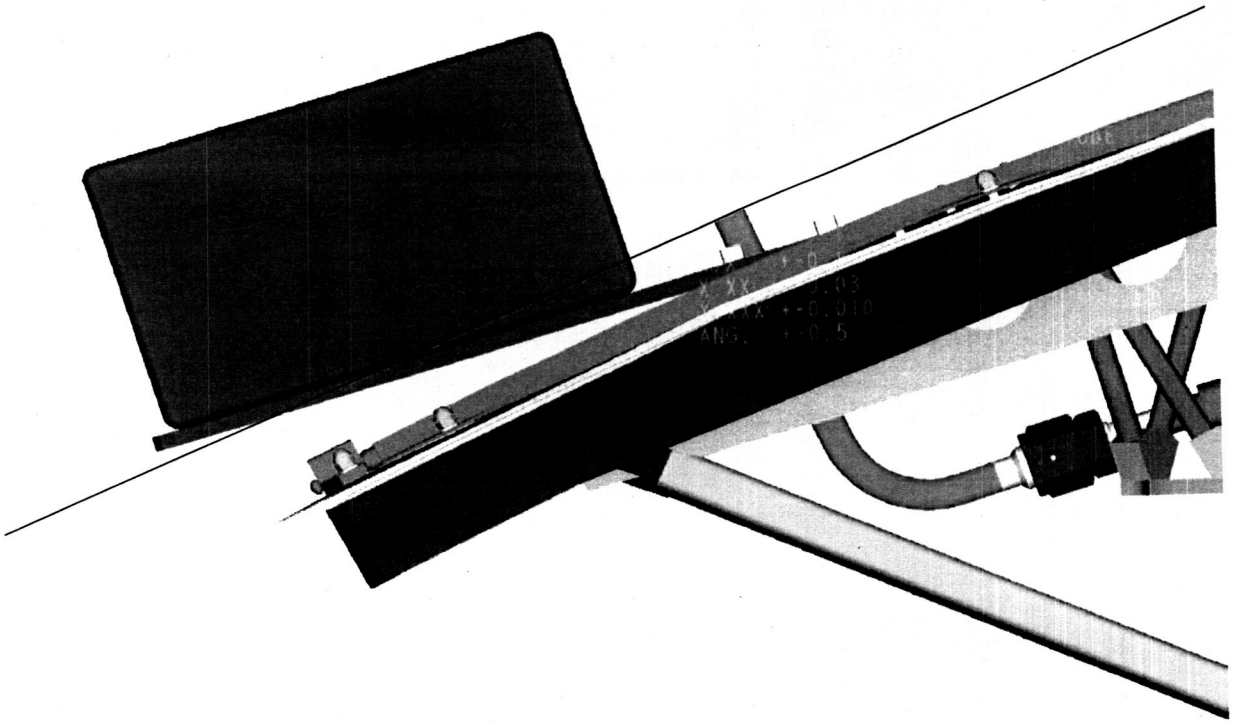
6-Channel ECU Box Mounted on WFC3



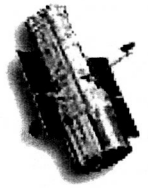




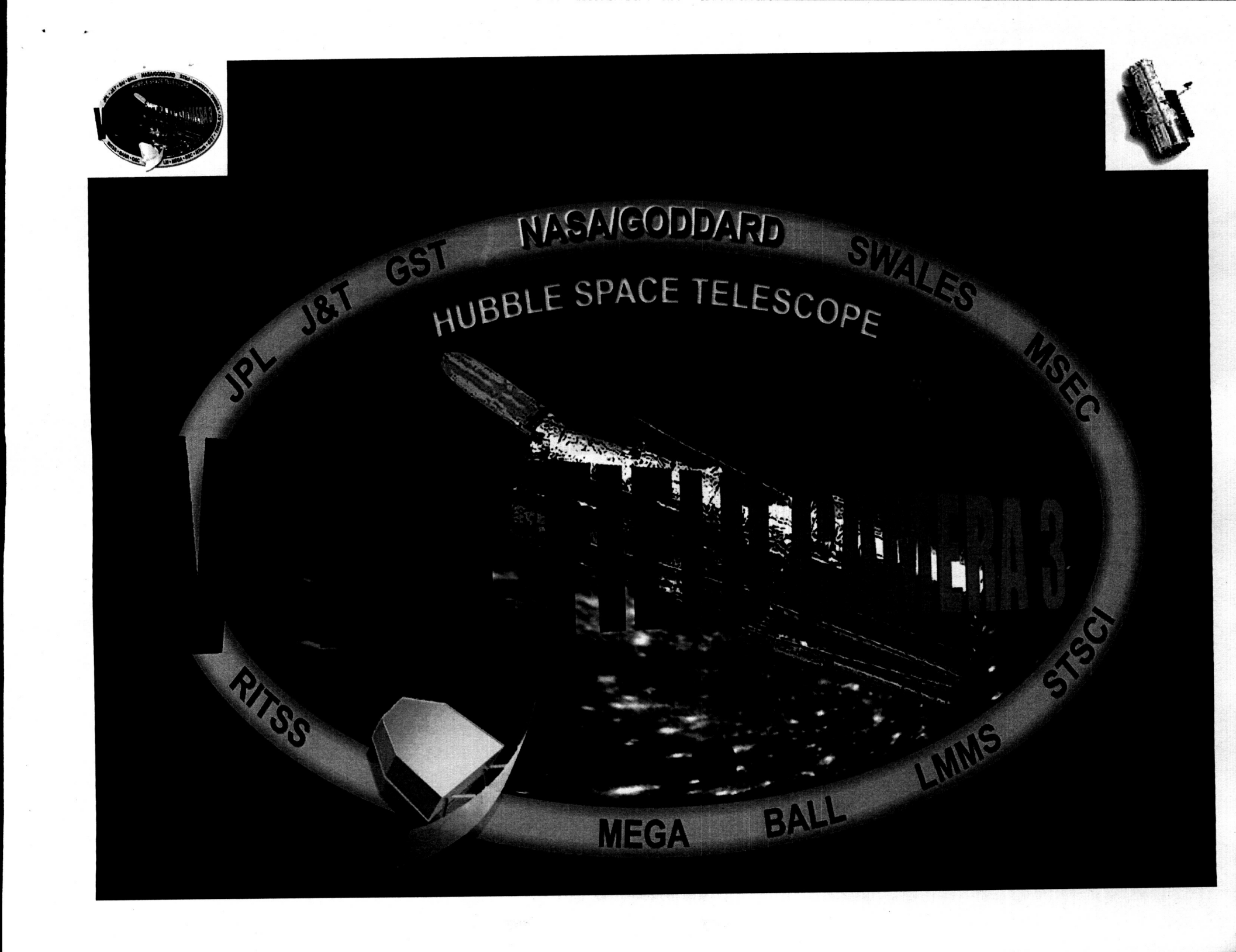
ECU in line of sight



Contamination Accommodations for IR Vent Tube (2 of 2)



- Possible solutions to avoid line of sight to vent port
  - Place molecular adsorbers near port opening
    - Functions properly until maximum capacity has been reached
  - Extend the length of vent tube beyond height of ECU box
    - Not suitable due to constraint of robot arm clearance
  - Move detector port location to other side of radiator (UVIS side)
    - Needed to re-analyze the time for venting of tube
      - Analysis was performed by Dr. Michael Woronowicz
      - Time for IR detector to reach required pressure: 157 hrs. (old), 338 hrs. (new)
    - Both time results are within 3-week design goal and acceptable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